SPECIFICATION

TITLE OF THE INVENTION

LUBRICATION SYSTEM FOR CRANKSHAFT

BACKGROUND OF THE INVENTION

The present invention relates to a lubrication system for a crankshaft, which is lubricated between a crankpin of the crankshaft and a connecting rod.

An engine includes a piston reciprocating in a cylinder, and a crankshaft rotatably mounted in a crankcase, wherein a piston and the crankshaft are connected through a connecting rod. To supply lubricating oil to contact portions of respective members constituting the engine, an oil pump is driven by the crankshaft. In a four-cycle engine, the lubricating oil from the oil pump is supplied also to contact portions between a crankpin of the crankshaft and a bearing incorporated in an end portion of the connecting rod.

In an assembly-type crankshaft formed by a plurality of members so that they are linked through the crankpin, a hollow crankpin can be used. Thus, in the crankshaft using the hollow crankpin, as described in patent document 1, a communication hole for communicating with a hollow hole and an outside periphery of the crankpin is formed in a diameter direction thereof, and the lubricating oil from the oil pump is supplied, through the hollow hole and the communication hole, to a contact portion between a rolling bearing fitted to the crankpin and the crankpin, whereby the lubricating oil is directly discharged into an outside

periphery of a rotating body of the rolling bearing.

Meanwhile, in a connecting rod of such a type that a sliding bearing is incorporated between the crankshaft and an end portion of a crankshaft side of the connecting rod, as described in patent document 2, a supply hole of the lubricating oil is formed in the connecting rod so as to communicate with an inner surface of the sliding bearing and an inner surface of a fitting hole to which a piston pin is fitted.

[Patent Document 1]

Japanese Patent Laid-Open (TOKUKAIHEI) No. 7-119428

[Patent Document 2]

Japanese Patent Laid-Open (TOKUKAIHEI) No. 5-106630

SUMMARY OF THE INVENTION

As described above, to supply the lubricating oil to the contact portion between the crankpin and the bearing fitted thereto, durability tests have been performed for the engine provided with the crankshaft in which an opening of a lubricating-oil supply path is formed on the outside periphery of the crankpin so as to face to an inner surface of the bearing. As a result of observation of the crankshaft after driving the engine over a long term, it has been found out that a flaking phenomenon occurs at a fringe, i.e., an edge of the opening of the lubricating-oil supply path formed in the crankpin. This flaking phenomenon is one in which the fringe of the opening is worn away, and if the flaking phenomenon occurs, the lubricating oil cannot be appropriately supplied to the contact portion.

Investigations of the reason for the occurrence of the

flaking phenomenon have shown that when a rolling bearing such as a roller bearing is mounted to the crankpin, a rotating body such as a roller of the rolling bearing rolls and contacts to the outside periphery of the crankpin, whereby a surface pressure applied to the outside periphery of the crankpin from this rotating body is such that the fringe of the opening is several times higher in the surface pressure than other portions. Thus, it is thought that when the high surface pressure is applied to the fringe of the opening, the flaking phenomenon occurs at the fringe at the very first due to the high surface pressure. If the flaking phenomenon occurs at the fringe at the very first, desired lubrication performance cannot be maintained even though there are no defects in other parts, and so the durability of the crankshaft is lost.

An object of the present invention is to provide a lubrication system for a crankshaft, which is capable of improving the durability of the crankshaft.

A lubrication system for a crankshaft according to the present invention is one which lubricates a connecting portion between a crankshaft rotatably mounted in a crankcase and connected to a piston in a cylinder via a connecting rod and said connecting rod, said lubrication system comprising: a crankpin attached to a crank web integrally provided with a journal portion to form said crankshaft; a bearing mounted on an end portion of said connecting rod and fitted to said crankpin; and a lubricating-oil discharging opening communicating with a lubricating-oil supply path formed in said crankshaft, said opening being formed on an end face of said crank web, wherein the

lubricating oil is discharged from said opening to an end portion of said bearing.

In the lubrication system of a crankshaft according to the present invention, said bearing is a rolling bearing having a rotating body. Further, in the lubrication system of a crankshaft according to the present invention, said crankshaft is formed by: a plurality of shaft elements each having a journal portion and a crank web integrally formed therewith; and a crankpin connecting the shaft elements attached to an attachment hole formed in each of the crank webs, and connecting the crank elements.

In the present invention, since the opening of the lubricating-oil supply path formed in the crankshaft is formed on the end face of the crank web, the lubricating oil can be supplied, through the end portion of the bearing, to the sliding portion between the bearing fitted to the crankpin and the crankpin. Therefore, it is unnecessary to form the opening of the lubricating-oil supply path on the outside periphery of the crankpin, and the surface pressure applied to the crankpin from the bearing becomes almost uniform over the entirety of the outside periphery of the crankpin. Accordingly, without the occurrence of the flaking phenomenon on the outside periphery of the crankpin, the durability of the crankshaft can be improved.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing an engine in which a lubrication system for a crankshaft according to an embodiment of the present invention is incorporated.

FIG. 2 is an enlarged sectional view showing a part of FIG. 1.

FIG. 3 is a perspective view showing one shaft element constituting a crankshaft.

FIG. 4 is a sectional view showing a part of a crankpin and a connecting rod as a comparison example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described in detail based on the drawings. FIG. 1 is a schematic diagram showing an engine in which a lubrication system for a crankshaft according to an embodiment of the present invention is incorporated, and FIG. 2 is an enlarged sectional view showing a part of FIG. 1.

This engine is a four-cycle single-cylinder one and can be applied as an engine of a vehicle such as a buggy, more specifically, applied as an engine of an ATV, namely, all-terrain vehicle. As shown in FIG. 1, this engine includes a crankcase 12 rotatably supporting crankshafts 11, and a piston 14 reciprocally incorporated in a cylinder 13 mounted in the crankcase 12. To transmit the reciprocating motion of the piston 14 to the rotary motion of the crankshaft 11, a connecting rod 17 is connected between a piston pin 15 fixed to the piston 14 and a crankpin 16 fixed to the crankshafts 11.

A cylinder head 18 is attached to the cylinder 13, and the cylinder head 18 and the piston 14 form a combustion chamber 19 in the cylinder 13. A suction port communicating with the combustion chamber 19 and supporting an air-fuel mixture and an exhaust port exhausting an combustion gas are formed in the cylinder head 18. An not shown suction valve for opening/closing the suction port

and an not shown exhaust valve for opening/closing the exhaust port are formed in the cylinder head 18, respectively. To open/close-drive the suction valve and the exhaust valve, a camshaft 20 is rotatably attached to the cylinder head 18, and a sprocket 21 fixed to the camshaft 20 is connected to a sprocket 22 fixed to the crankshaft 11 via a chain 23. Therefore, the camshaft 20 is driven by the crankshaft 11.

A rocker shaft 24 parallel to the camshaft 20 is rotatably mounted in the cylinder head 18, and a rocker arm 25 for open/close-driving the suction valve and a rocker arm 26 for open/close-driving the exhaust valve are rotatably mounted on the rocker shaft 24. One end portions of the rocker arms 25 and 26 come in contact with valve-operating cams 27 and 28, respectively, and the suction valve and the exhaust valve are attached to the other end portions thereof.

In the engine shown in FIG. 1, a generator case 31 is attached to the crankcase 12, and a generator 32 is mounted in this generator case 31. The generator 32 includes an outer rotor 34 provided with magnets 33 and a stator 36 provided with coils 35, wherein the outer rotor 34 is fixed to the crankshaft 11 and the stator 36 is fixed to the generator case 31. The electric power generated by the rotation of the crankshaft 11 is supplied to an not shown battery from this generator 32, whereby the battery is charged.

As shown in FIG. 2, the crankshaft 11 is rotatably mounted in the crankcase 12 by bearings 37 and 38 attached to the crankcase 12. The crankshaft 11 shown in FIG. 2 has two shaft elements 11a and 11b, and one shaft element 11a is shown in FIG. 3. As shown

in FIG. 3, the shaft element 11a is provided with a journal portion 41a rotatably supported by the bearing 38, and a crank web 42a integrally formed with an end portion of the journal portion 41a. The crank web 42a has a crank arm portion 43a protruding in a diameter direction, and a balance weight portion 44a protruding in a direction opposite to that of the crank arm portion 43a, wherein an attachment hole 45a is formed in the crank arm portion 43a. Similarly, also in the other shaft element 11b, a crank web 42b integrally provided with a journal portion 41b includes a crank arm portion 43b and a balance weight portion 44b, wherein an attachment hole 45b is formed in the crank arm portion 43b.

The crankshaft 11 is formed, by coupling the two shaft elements 11a and 11b through the crankpin 16 fitted into the attachment holes 45a and 45b, and the crankpin 16 has a communication hole 47 therein and so becomes hollow. In the connecting rod 17 connecting the crankshaft 11 and the piston 14, a link end portion 49 having a fitting hole 49a to which the piston pin 15 fixed to the piston 14 is fitted is provided on one end thereof. In a link end portion 51 provided at the other end thereof, a fitting hole 51a to which a bearing 50 fitted to the crankpin 16 is fitted is formed. The bearing 50 is provided with a plurality of rotating bodies such as rollers 52, and a retainer 53 having a groove rotatably accommodating the respective rollers 52.

A lubricating-oil supply path 55 having an opening 54 on an end face of the crank web 42a is formed in the shaft element 11a of the crankshaft 11, and the lubricating-oil supply path 55 communicates with an not shown discharge port of the oil pump.

The lubricating-oil supply path 55 and the discharge port of the oil pump may communicate with each other through an oil path formed in the crankcase 12, or through a joint portion provided at the end portion of the crankshaft 11. The opening 54 of the lubricating-oil supply path 55 is formed so as to face to an end face of the bearing 50. The lubricating oil discharged from the oil pump serving as a lubricating-oil supply source is supplied into the inside of the bearing 50 from a side of the end portion of the bearing 50, and the outside periphery of the crankpin 16 and the roller 52 rolling along the outside periphery thereof are contacted via an oil film.

The lubricating-oil supply path 55 communicates with the communication hole 47 in the crankpin 16, through a communication oil path 56 formed in the crankshaft 11 and a communication hole 56a formed in the crankpin 16 so as to communicate with the oil path, whereby the lubricating oil is supplied to the communication hole 47. Plugs 57a and 57b are fixed at both ends of the communication hole 47 of the crankpin 16, and a discharge hole 58 for supplying the lubricating oil to the bearing 37 is formed in the plug 57a. However, if the lubricating oil can be supplied to the bearing 37 through the other oil path, it is unnecessary to provide the communication oil path 56 and the communication hole 47.

As described above, the opening for discharging the lubricating oil is not formed in a partial one on which the roller 52 rolls in the entire outside periphery of the crankpin 16, whereby the outside periphery of the crankpin 16 becomes wholly flat. As a result, without locally increasing the surface

pressure at the outside periphery of the crankpin 16 by loads applied from the roller 52, the wholly uniform surface pressure is applied to the outside periphery of the crankpin 16. Therefore, the flaking phenomenon on the outside periphery of the crankpin 16 does not occur even after the engine has been used over a long term, whereby the durability of the crankshaft 11 can be improved.

FIG. 4 is a sectional view showing a part of the crankpin 16 and the connecting rod 17 as a comparison example. In this comparison example, to supply the lubricating oil to the bearing 50 from the communication hole 47 similarly to the conventional ones, a lubricating-oil supply path 60 opening to the outside periphery of the roller 52 of the bearing 50 is formed in the crankpin 16. When the lubricating-oil supply path 60 is thus formed in the crankshaft 16 by opening to the outside periphery of the roller 52, the roller 52 contacts to a fringe of such an opening with some large surface pressure. Therefore, a flaking phenomenon 61 occurs at the fringe of the opening due to secular change in the crankpin 16, and the lubrication performance is changed. However, such a flaking phenomenon does not occur in the crankshaft 11 of the present invention, whereby the durability of the crankshaft 11 can be improved.

The present invention is not limited to the above-mentioned embodiment, and can be variously modified and changed without departing from the gist thereof. For example, the crankshaft 11 illustrated in the drawings is for the single-cylinder engine. However, the present invention can also be applied to a crankshaft for multi-cylinder engine. Further, the engine provided with the crankshaft 11 can be applied as an engine for motorcycle or a

multi-purpose engine for generator besides the ATV. Furthermore, the crankshaft 11 illustrated in the drawings is of such an assembly type as to connect the shaft elements 11a and 11b through the crankpin 16. However, it is also possible to apply the present invention to a crankshaft of an integrally formed type. Additionally, a needle bearing can be used as the rolling bearing as well as the roller bearing.

According to the present invention, since the opening of the lubricating-oil supply path formed in the crankshaft is formed on the end face of the crank web, it is possible to supply the lubricating oil to the sliding portion between the bearing fitted to the crankpin and the crankpin, through the end portion of the bearing. Therefore, without the occurrence of the flaking phenomenon on the outside periphery of the crankpin, the durability of the crankshaft can be improved.

The entire disclosure of a Japanese Patent Application No. 2003-087522, filed on March 27, 2003 including specification, claims, drawings and summary, on which the Convention priority of the present application is based, are incorporated herein by reference in its entirety.